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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Ecologically sustainable cassava plant protection in South America and Africa: an environmentally sound approach (GLO/91/013)

International Institute for Tropical Agriculture (IITA) and Centro Internacional de Agricultura Tropical (CIAT)

Recommendation of the Administrator

Estimated UNDP contribution	$10 084 000
Duration	Four years
Executing agency	OPS

I. BACKGROUND

1. Brazil is the world's largest cassava producer with 58 per cent of its production (approximately 14.5 million tons) found in the north-east region. Most cassava in this region is grown by tenant farmers who cultivate plots of less than one hectare on infertile soil and with limited rainfall. Cassava productivity in the north-east is a third less than in the rest of Brazil. Africa accounts for 40 per cent of the world's total cassava production; and one third (17 million tons) of African production is in West Africa. Cassava is a food staple and the most important source of carbohydrates for at least

75 million Africans. Cassava is grown by small-scale farmers, mostly women on plots of less than half a hectare. Production rarely exceeds 8 tons per hectare. In general, cassava is able to grow under conditions that are unsuited for other crops, and is frequently the crop that sustains populations during droughts. It is an important food staple for both the rural and the urban poor.

2. Cassava demand in Africa and north-east Brazil is increasing and is resulting in intensification of production. However, pests represent a significant production constraint in both areas. The intensification of cassava production is making commercial pesticide usage increasingly attractive, and this can only be restrained if an economical and feasible alternative for pest control is developed and applied as soon as possible. Thus, the need for appropriate crop protection technology that is not based on synthetic pesticides is especially critical. Cassava pests, including arthropods, pathogens and weeds, can reduce cassava production by as much as 50 per cent and it is critical to develop and apply environmentally sound pest management systems before synthetic pesticide usage becomes entrenched.

3. Appropriate combinations of biological control, resistant germplasm and cultural practices are the basis of ecologically sound plant protection. Traditional systems of cassava-based cultivation are an ideal starting point for the development of cassava protection practices. Extreme remedial control measures, such as the use of pesticides, are only necessary if and when the ecological approach fails to provide an adequate solution. This strategy conserves the efficacy of natural enemies and preserves the environmental integrity of the food-chain within the agro-ecosystem.

4. Women have a primary responsibility for cassava production in Africa. However, women only occupy 7 per cent of government extension-service positions, and hold fewer than 4 per cent of the professional agricultural positions, even though they produce as much as 70 per cent of the domestically consumed food.

5. IITA and CIAT have worked together over the last decade to develop sustainable cassava protection technologies for Africa and South America. This Latin America-Africa cooperation provides access to natural enemies, resistant germplasm, and production expertise that is essential for national programmes aimed at developing and implementing appropriate cassava protection technologies. The catalyst that initiated IITA and CIAT collaboration was the introduction to Africa of the cassava mealy bug from South America. This pest spread rapidly throughout the continent and produced widespread devastation. With support from the UNDP intercountry programme for Africa, the International Fund for Agricultural Development (IFAD) and other donors, IITA thus initiated a classical biological control campaign in the early 1980s, and CIAT assisted by locating the natural enemies of the mealy bug in South America. IITA then reproduced the natural enemies and implemented the release and follow-up campaign in Africa. Today, the cassava mealy bug is substantially controlled in Africa as a direct consequence of this effort. This international collaboration resulted in one of the most successful

biological control campaigns ever undertaken. A recent economic analysis shows that the benefit:cost ratio of this control campaign was conservatively estimated at 149:1.

6. In summary, cassava cultivation in parts of Africa and north-east Brazil is practised under a set of ecological agronomic and socio-economic conditions and constraints that have much in common. Demand for cassava in both regions is increasing, and is resulting in intensification of production. Through bilateral collaboration and networking with other international and national institutions, CIAT and IITA have developed the knowledge base, technology components, training expertise and farmer participatory methodology necessary to develop an integrated approach to cassava pest control, decreasing the need for and the use of commercial pesticides.

II. THE PROJECT

7. This project will be carried out in Africa by IITA in collaboration with national programmes in Benin, Cameroon, Ghana and Nigeria, and in South America by CIAT in collaboration with Empresa Brasileira de Pesquisa Agropecuaria in north-east Brazil. The four interested countries in Africa have ecologically similar production areas, are accessible by road and air, and possess the necessary institutional capacity and commitment to contribute to and benefit from the project. The activities to be carried out in these sub-regions may become a model for other cassava growing countries and regions in Africa and South America.

8. The project will develop, test and implement sustainable cassava protection technology for the most damaging cassava insect pests found in north-east Brazil and in the African countries. It will feature collaboration with national plant protection staff, extension workers and farmers from Brazil, Ghana, Benin, Nigeria and Cameroon. In order to increase the probability of technology adoption, extension workers and farmers will be trained in the principles and practices of sustainable cassava protection. In a special effort to enhance the capacity of African women in national systems, IITA will provide African women from each participating country with M.Sc. (or equivalent) training fellowships. These women candidates may also participate in the African Women Leaders in Agriculture and the Environment programme of the Winrock International Institute for Agricultural Development, which is an effort to enhance women's skills in policy, management, research and extension.

9. The specific objectives of the project are to:

(a) Assemble multi-disciplinary national programme teams in each participating country and develop detailed workplans for diagnostic surveys in order to identify and map the major pest constraints, farmers' perceptions and current practices;

(b) Ascertain the level and type of research required to overcome the major pest constraints identified through the diagnostic surveys and identify sites for farmer evaluation of available cassava protection technologies;

(c) Develop training materials for national programme staff, extension workers, farmers, and train researchers, extension workers and farmers in the principles and practices of ecologically sustainable crop protection;

(d) Test, adapt and evaluate pest control technologies in collaboration with farmers, extension workers, and national programme staff; and estimate potential impact of tested pest control technologies over a range of ecological, agronomic and socio-economic conditions;

(e) Evaluate the effectiveness and impact of the training programme and the effect of the adoption and impact of the technology components adapted by farmers.

10. In support of the above plan, methods will be developed for decentralized mass rearing and field release of biological control agents. Other research will be concerned with strain selection of cassava green mite, fungal pathogens, root rot etiology, impact of biological control agents on non-target organisms, screening technology components for undesirable environmental effects, and development of strategic and tactical models. Support activities for the project include mass production of natural enemies for use in farm trials and by national programmes, multiplication of planting material, shipments of natural enemies from South America to Africa via quarantine in the Netherlands, and shipments of natural enemies from CIAT to Brazil via quarantine at the Centro Nacional de Pesquisa para Defesa da Agricultura, Jaguariuna, São Paolo, Brazil. In addition, limited expert technical assistance will be offered by Texas A & M University (United States), and the University of California (Berkeley) (United States), in systems modeling. Finally, the Food and Agriculture Organization of the United Nations (FAO) will assist in aspects of the country training activities.

11. The potential benefits of this project to the people of Brazil, Ghana, Nigeria, Benin and Cameroon include the following:

(a) Enhanced capability of national programmes for research on plant protection problems with sustainability as a major objective; and development of information resources to facilitate the implementation of similar initiatives in the future;

(b) Improved cassava productivity for small-scale cassava farmers;

(c) Enhanced environmental quality and human health.

12. There are several features of the proposal that recommend it for the support of the Division for Global Interregional Programmes. First, it is concerned with production and sustainability of a major staple food for

low-income populations in Africa and Latin America. Second, the collaboration between two institutes of the Consultative Group on International Agricultural Research, scientists, extension agents and farmers in five developing countries will promote rapid development of the technology and extension to farmers. Third, the proposal emphasizes the dominant role of women in African cassava production. Finally, the intensification of cassava production is making commercial pesticide usage increasingly attractive, and this can only be restrained if an economical and feasible alternative for pest control is developed and applied as soon as possible. The project, therefore, contributes to the following UNDP themes identified by the thirty-seventh session of the Governing Council: environment and natural resource management; TCDC; technology for development; poverty eradication, and women in development.

13. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

14. The total cost of the four-year project is $10,084,000, 62 per cent of which will be spent in Africa and 38 per cent in Latin America. The African budget allocates approximately 40 per cent to R & D at IITA, 29 per cent to IITA training and coordination, and 31 per cent to research, training and extension in the four collaborating countries. The Latin American budget allocates roughly 46 per cent to CIAT research, training and coordination, and 54 per cent to research, training and extension in Brazil. Estimated counterpart contributions include the following: CIAT ($1,872,000); IITA ($1,700,000); Benin, Cameroon, Nigeria, Ghana ($20,000 each); and Brazil ($1,418,000).

III. RECOMMENDATION OF THE ADMINISTRATOR

15. The Administrator recommends that the Governing Council approve this project.

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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Reducing maize losses to insect pests by enhancing host plant resistance with bacillus thuringiensis toxin genes (GLO/91/014)

International Maize and Wheat Improvement Centre (CIMMYT)

Recommendation of the Administrator

Estimated UNDP contribution	$6,250,000
Duration	Five years
Executing agency	OPS

I. BACKGROUND

1. Maize is a staple cereal for people throughout the world and ranks third in importance after wheat and rice in annual production. Data on 29 major maize production countries of the developing world indicate that 55 per cent of the total area is seriously affected by insect pests. Field and storage pests typically cause losses of 20 per cent or more in developing country maize production. Lepidopteran insects are among the most important of these pests in the developing world. Globally chemical control of maize insect pests is estimated to cost more than $3 billion per year.

2. Synthetic chemical control of insects is increasingly viewed as a threat to human health and the environment. Concern about small-scale farmers using pesticides is especially serious given their generally poor knowledge of pesticide safety and their inability to afford appropriate safety devices, etc. Thus, there is a growing awareness of the potential hazards associated with the formulation, manufacture, transport, mixing, application, and disposal of synthetic chemical pest controls, and agreement on the need for alternative effective and economical control technologies.

3. Private companies in the developed world have invested millions to develop genetic engineering techniques for temperate maize improvement. These recent advances in biotechnology will expand the pool of genes available to temperate maize breeders. However, realizing the promise of this technology for tropical maize in developing countries implies a sizeable resource investment. Furthermore, a collaborative research involving both public and private sector entities is the most expeditious strategy to realize the development and application of biotechnology in tropical maize improvement.

4. Many developing countries are concerned about the growing disparity between North and South in the development of and access to modern molecular and cellular biology and genetics. The fact that much of the current technology is proprietary, especially in an important commercial crop such as maize, exacerbates their concern. By bringing the private sector into a collaborative research programme on tropical maize, this project will assist developing countries to gain access to advanced technology.

II. THE PROJECT

5. The UNDP contribution is part of a larger International Maize and Wheat Improvement Centre (CIMMYT) programme to transform tropical maize in order to increase sustainable production and significantly reduce the need for synthetic chemical pesticides on maize in the developing world. The project will use advanced technology from public and private sources to generate tropical maize germplasm that has enhanced and durable resistance to major insect pests of maize (primarily from Africa and Latin America) and eventually provide improved germplasm to breeders and farmers in developing countries. The strategy will be to strengthen the insect resistance genes already available from various maize sources by the addition of genes from the soil bacterium Bacillus thuringiensis (B.t.). These bacterial genes encode proteins toxic to specific maize lepidopteran species. Thus, the new technology now allows us to introduce promising insect resistance genes from B.t. into tropical maize. The procedure, known as transformation, incorporates the gene into the new host, enabling the latter to produce an entirely new plant constituent. To obtain this goal in a timely and cost-efficient manner, UNDP will support a coalition of public and private entities working with CIMMYT on specific technical aspects of the project. CIMMYT would enter into arrangements with individual collaborators based on research results, performance, new developments in biotechnology, and within the existing guidelines and regulations for the development, testing, and release of the products of genetic engineering.

6. Certain advanced laboratories in developing country programmes will assist CIMMYT and are undertaking research of direct relevance to the project. For instance, the National Maize and Sorghum Research Centre of the Brazilian Agricultural Research Enterprise has already located some strains of B.t., conducted biological control studies involving specific maize pests, and identified tropical maize genotypes with high embryogenic formation and regeneration capacity that will be useful in the transformation process. The Centre for Research and Advanced Studies of the Mexican National Polytechnic Institute has isolated several hundred B.t. strains from samples taken throughout Mexico and cloned genes of B.t., kurstaki and tenebrionis that encode crystal proteins toxic to various Lepidoptera and Coleoptera. These laboratories are participating in a Latin American biotechnology network through a regional programme supported by UNDP and are now performing joint research with CIMMYT on maize tissue culture and B.t. toxicity to maize pests. In addition, the Centre de Coopération Internationale en Recherche Agronomique pour le Développement in France will make a substantial scientific contribution to the research.

7. Large international companies have invested considerable resources and already achieved notable progress in temperate maize transformation. Their efforts have focused on transforming temperate maize to enhance its resistance to insect pests of North America and Europe. Based on a comprehensive analysis, it is clear that no substantial effort is being made in the private sector to transform tropical maize for developing country markets. Without a sustained multilaterally led coalition of research collaborators, it is unlikely that the transformed tropical maize or the underlying technology will soon reach developing countries. To determine the possibility of gaining access to this technology, CIMMYT has approached several European and North American companies that reported successful transformation of temperate maize. The Centre has opportunities for agreements whereby CIMMYT would obtain advanced technology for screening, manipulating, and transferring B.t. genes into tropical maize and at a fraction of the cost of the Centre developing this technology on its own or through other public sector institutions.

8. CIMMYT agreements with public and private sector institutes will be based on performance and development of specific products. In some cases, CIMMYT may ask different collaborators to develop the same product. This strategy would promote competition between providers of key products and ensure the quality and punctual delivery of those components.

9. The following objectives will be pursued:

(a) Identification of at least three Bacillus thuringiensis strains that harbour endotoxin genes with effective insecticide action against the major lepidopteran insect pests of tropical maize;

(b) Identification, characterization and isolation of the genes encoding specific B.t. crystal proteins with high levels of toxicity for maize insect pests;

(c) Preparation of gene constructs that allow the expression of crystal protein genes in transgenic maize plants;

(d) Development of appropriate tissue culture technology for regeneration of tropical maize;

(e) Introduction and expression of the B.t. genes in tropical maize plants.

10. It is expected that by the end of the project, CIMMYT will have fertile maize plants that contain genes encoding the endotoxin of Bacillus thuringiensis which express sufficient levels of this protein to confer significant resistance to the major lepidopteran insect pests of tropical maize. It is also expected that these plants will be of advanced genotypes and will thus already possess some resistance to multiple tropical borer species. Thus, they will be of interest to maize breeding programmes of developing countries and private seed companies. It is expected that this maize will allow developing country farmers to obtain increased and stable yields with less need for synthetic chemical pesticides.

11. Questions on (a) biosafety during the research and development on maize transformation; (b) subsequent release of transformed maize and its potential impact on the environment; (c) legal restrictions on the marketing of the transformed maize and free access of the CIMMYT transformed maize germplasm to all countries, have been considered. All research and development will be done under relevant national regulatory legislation or in its absence with government approval and under regulations in force in developing countries. Secondly, no transformed maize will be released for distribution or field testing until all relevant environmental impact criteria are fully satisfied and specifically approved by the Governments concerned. If a country does not have relevant environmental impact criteria, government approval will be requested on the basis of other generally accepted criteria from developed countries. Lastly, CIMMYT policy stipulates that all genetic material is available to any interested Government or responsible private party.

12. The UNDP contribution will be executed through the Office of Project Services with overall direction from the Division for Global and Interregional Projects (DGIP), and implemented by CIMMYT in conjunction with a number of public and private entities. A programme oversight committee will be appointed that will include UNDP and invited outside consultants from developing and developed countries and the Food and Agriculture Organization of the United Nations (FAO) (experts on biotechnology, environmental regulations, research and development management). The committee will be appointed by CIMMYT in consultation with the Administrator of UNDP. The group will meet annually to review and approve the research plans for the following year. The oversight committee will review and provide recommendations on all research sub-contracts.

13. The proposal has several features that recommend it for a global project. At least two advanced laboratories in developing countries will collaborate with CIMMYT and the private sector companies in North America and Europe in an effort to bring the most advanced technology available to tropical maize improvement. In addition, the Centre de Coopération Internationale en Recherche Agronomique pour le Développement will make a research contribution to the project. The project will produce tropical maize germplasm that will resist attack from several very serious insect pests that inflict heavy yield losses in Africa, Asia and Latin America. Thus, the proposal emphasizes three major themes that were identified by the Governing Council in its decision 90/34 which are: technical cooperation among developing countries; transfer and adoption of technology for development, and natural resource management for sustainable development. The genetic materials, methodologies and supporting systems developed through the project will directly benefit maize research throughout the tropical world as they produce new pest-resistant tropical maize varieties. The ultimate beneficiaries of this project will be the general public in maize-producing countries, who should experience a reduction in the levels of synthetic pesticides in the environment, and have at their disposal less expensive and larger supplies of maize.

14. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

15. Of the total budget of $6,250,000, at least 53 per cent will be used to support collaborative efforts with public institutions in Mexico, Brazil and France and with private biotechnology companies. Private sector companies with proprietary knowledge and a possible interest in collaborating with CIMMYT may include companies in Europe and North America.

III. RECOMMENDATION OF THE ADMINISTRATOR

16. The Administrator recommends that the Governing Council approve this project.

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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Genetic improvement of farmed tilapia - GLO 90/016

Recommendation of the Administrator

Estimated UNDP contribution	$4,822,690
Duration	Five years
Executing agency	OPS

I. BACKGROUND

1. The problem of protein malnutrition among disadvantaged populations of the developing world is increasing, especially owing to increased scarcity and high cost of animal protein sources. Fish already provides the primary source of animal protein for over one billion people in many developing countries and contributes substantially to national economies. Increased production of fish will be a major source of protein to supply the increasing world population.

2. The demand for fish has grown substantially over the past few decades and the fisheries sector is under heavy pressure. While fish supply has been mainly based on harvesting wild populations, prospects for further sustainable increased catches from capture fisheries are very limited. The Food and Agriculture Organization of the United Nations (FAO) projects an annual increase of only 0.3 per cent. Moreover, many traditional fishing grounds

are heavily exploited and some wild stocks are in danger of extinction. Consequently, the major source of increased fish supply can only come from aquaculture.

3. Aquaculture will have a major role in producing a growing proportion of the world's fish supply. While at present 13.5 per cent of fish supply in developing countries comes from aquaculture, the demand for fish from aquaculture systems is expected to increase rapidly. For aquaculture to respond to this demand, concerted research efforts are urgently needed to improve the efficiency of present fish farming practices, especially for tropical species.

4. Genetic research and the application of breeding programmes have been major contributors to the significant production improvements in agriculture over the past 40 years. For example, the time to produce a 1.7 kg broiler chicken has been reduced from 14 weeks to 7 weeks and the amount of feed reduced to one half. In the case of aquaculture, genetic selection programmes can also make major contributions to increasing productivity and profitability. After 15 years of accumulated selection and improved feeding and management, productivity in the Norwegian salmon aquaculture industry has increased by 60-70 per cent.

5. Tropical aquaculture species, such as carps and tilapias, which form the mainstay of small-scale enterprises for many resource-poor farmers in the developing world, possess the ability to convert natural feed sources into high quality protein. For tilapias, conservative estimates of the levels of production gains that can be readily achieved through genetic selection are of the order of 8-16 per cent per year.

6. Unfortunately, efficient breeding and genetic selection programmes are rarely practised for important tropical fish species even though the tradition of fish farming dates back thousands of years. There are several reasons for this. Aquaculture research in general and genetic improvement research in particular, have been hampered by short-term, scattered and disjointed funding. Long-term strategic research efforts have been neglected. Research methodologies and rigorous protocols are therefore poorly developed. Based on its work during the previous decade, the International Centre for Living Aquatic Resources Management's (ICLARM) aquaculture programme has identified key problem areas requiring long-term investigations that include breeding, genetics and integrated agriculture-aquaculture food production systems.

7. ICLARM has given a high priority to achieving increased food production and income by and for low-income small-scale producers. The first priority in this research is tilapia, which forms the mainstay of small-scale aquaculture for many resource-poor farmers. The focus is on the Nile tilapia (Oreochromis niloticus) which has wide appeal throughout the tropics. The experiences gained with Nile tilapia will help to indicate approaches that can be adapted and applied to other finfish species, notably carps and other indigenous species, in national breeding programmes. Potential collaborating countries include China, India, Thailand, Ghana and Malawi. ICLARM already has a major fisheries project operating in Malawi.

8. Tilapias possess an impressive range of attributes for aquaculture: excellent growth rates on low protein diets (natural or artificial); tolerance of wide ranges of environmental conditions; freedom from serious diseases and parasitic infestations; ease of handling and breeding in captivity and wide acceptability as a foodfish. Tilapias are therefore widely recognized as a prime domesticated species for farming in a wide range of aquaculture systems. For this reason, tilapia has been called the "aquatic chicken". The origin of tilapias is Africa but a few species have been introduced into most tropical and subtropical Asian countries. Annual production exceeds 50,000 metric tons in several Asian countries. In Asia, tilapia production contributes about 10 per cent of the total aquaculture of finfish. There is significant tilapia culture in Bangladesh, China, Indonesia, the Philippines, Sri Lanka, Thailand and Viet Nam.

9. ICLARM, an autonomous, non-profit fisheries research and training centre, was established in 1977 and has received support from a number of multilateral, bilateral and private sources. ICLARM has been conditionally invited to join the Consultative Group on International Agricultural Research and has presented its strategic plan to CGIAR Technical Advisory Committee. Fish germplasm enhancement and breeding are seen as major strategic research areas for ICLARM's future programme.

10. A small pioneering collaborative research project on the genetic improvement of tilapias, funded by UNDP (INT/88/019) and the Asian Development Bank, is being executed by ICLARM in cooperation with a research centre and two universities in the Philippines and with the Norwegian Institute of Aquaculture Research. This project has collected, transported and characterized diverse and promising tilapia germplasm from Africa (Egypt, Ghana, Kenya and Senegal) and "genetically narrow" strains of African origin that are currently farmed in the Philippines; established a Tilapia Germplasm Reference Centre; standardized techniques for further research; evaluated the growth performance of African and "Philippine" strains in different farming systems and agro-climatic conditions; trained project personnel and built a base population of the 25 best-performing genotypes. The base population developed in this project is already showing at least 30 per cent (up to 60 per cent) faster growth when compared with the most widely cultured commercial strain in the Philippines. Selection experiments to determine the magnitude of further genetic gains are under way. A conservative projected rate of gain is about 10 per cent per generation. Collaboration has already been initiated with other donors in this field including the International Development Research Centre, Overseas Development Administration (United Kingdom), Norwegian Agency for Development Corporation and the Commission of the European Communities as well as with the Network of Aquaculture Centres in Asia and the Food and Agriculture Organization of the United Nations.

II. THE PROJECT

11. The project will focus on four key areas: (a) the selection and dissemination of improved breeds; (b) the investigation of genetic traits leading to efficient breeding and selection programmes; (c) the documentation and collection of promising strains, and (d) strengthening the capacity of national institutions to carry out selection work and develop breeding programmes.

12. The selection of improved breeds will be carried out over about six generations. In each cycle, about 200 families will be produced and each individual will be tagged and distributed to different test environments for grow-out, evaluation and selection. Rigorous standards will be applied at all stages. Detailed guidelines and protocols for the dissemination of improved breeds will be developed with international experts in order to ensure that there is no adverse environmental impact. A self-sustaining breeding programme with private sector and government hatchery involvement will be established for the Philippines and guidelines will be prepared for similar work in other countries. This programme of work is unique in tropical developing countries and will produce, in addition to improved germplasm for Nile tilapia and guidelines for breeding programs, protocols for fish quarantine, germplasm cryopreservation, farmer-research interactions (user-perspective monitoring), and assessment of possible social and environmental impacts of improved breeds.

13. The investigation of the genetics of economically important traits and their relationship will lead to more efficient breeding and selection programmes. These investigations will involve field studies aimed at developing a well-defined breeding protocol on traits important to farmers and consumers. Other research related to the measurement of genetic traits and their use in selection will also be carried out.

14. The project will document and collect germplasm for strategic research. It will also evaluate new germplasm for aquaculture purposes and help in the development of protocols for the conservation and utilization of genetic resources.

15. A key element is the project's work in strengthening the capacity of national institutions to carry out selection work and develop national breeding programmes. This will be done through regular training workshops, specialized training for cooperating scientists from the Philippines and other countries, post-graduate training for graduate students, interregional workshops and an international conference.

16. The project is ultimately aimed at benefiting resource-poor fish farmers in developing countries, who will achieve a more stable increase in productivity. This increase in production of relatively cheaper fish protein will provide a dependable source of affordable animal protein for rural and urban consumers. Profitability will be an incentive for many families to start small-scale aquaculture enterprises. Women are also actively involved

in aquaculture enterprises, particularly at the family and community levels. In Bangladesh, 40 per cent of new entrants to tilapia and puntius (silver barb) culture are women. Their role in production and distribution activities is well recognized. The immediate beneficiaries will be the scientists of the national, regional and international institutions involved in aquaculture genetics research. The close involvement of scientists from the Philippines and other countries and regional organizations will be ensured through various means, including cooperative research networks.

17. UNDP and the World Bank have joined with the Commission of the European Communities and FAO to launch a study of international fisheries research and develop a related strategy and action plan for donor coordination. The proposed project covers one of the priority fields identified for strategic research and incorporates cooperative modalities which are fully in line with the strategy and action plan. The project also addresses issues identified in UNDP's fifth cycle global and interregional programme. The project will be executed by the Office of Public Services project.

18. The proposed total UNDP contribution is $4,822,690. Out of this total contribution, 36 per cent is for ICLARM, 32 per cent for the three collaborating organizations and 32 per cent for outreach to other organizations.

III. RECOMMENDATION OF THE ADMINISTRATOR

19. The Administrator recommends that the Governing Council approve this project.

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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

Biotechnology assisted breeding to reduce pesticide use in potato production (GLO/91/016)

Centro Internacional de la Papa (CIP)

Recommendation of the Administrator

Estimated UNDP contribution	$4 675 000
Duration	Three years
Executing agency	OPS

I. BACKGROUND

1. The potato is the fourth major basic food crop in the world. It is grown in 94 developing countries of Asia, Africa and Latin America, producing over 67.5 million tons of food annually on about 5.7 million hectares of land. Production is rapidly expanding in most of these countries.

2. Potato production in the developing world is constrained by a variety of biological and environmental stresses. It is attacked by more than 250 diseases and pests and is the heaviest user of synthetic chemical pesticides of all food crops. In most countries, farmers often protect their crop by routinely using synthetic chemical pesticides on a calendar basis. For example, China produces over 30 million tons of potatoes annually and it is

estimated that synthetic chemical pesticides valued at $140 million are applied each year. In Colombia, the estimated cost of spraying chemical pesticides (mainly for late blight) is about $14 million per year.

3. In many developing countries, both men and women cultivate potatoes, including spraying of synthetic chemicals and thus risking exposure to toxic pesticides. Furthermore, chemical dusting or spraying to protect potatoes in storage against the tuber moth may introduce synthetic chemicals into the diets of many households. This is especially dangerous since the potato is gaining popularity as a nutritious post-delivery food for mothers and as a weaning food for infants. The World Health Organization estimates that synthetic chemical pesticides poison 3 million people each year. One in fourteen dies. There is also much documentation suggesting that chemical pesticide contamination from cultivated crop lands is accumulating in groundwater, rivers and streams.

4. In order to reduce the dependence on pesticides and its negative health and environmental effects, classical breeding efforts are under way to obtain varieties that are more resistant to major potato pests and diseases. Better technology will hasten this process. In addition, biological control agents such as pathogenic fungi, parasitic wasps, and pheromone traps are being developed for use in future integrated pest management programmes. Previous studies at the Centro Internacional de la Papa (CIP) and other collaborating institutions indicate that hairs on leaves (trichomes) secrete sticky substances and trap insects, and provide broad-spectrum resistance against pests. Insects that may be controlled in this manner include the aphids which serve as vectors for potato viruses, the potato tuber moth, the Colorado potato beetle, potato leafhoppers, thrips and mites. Thus, it is imperative to incorporate this characteristic into modern potato varieties as soon as possible.

II. THE PROJECT

5. A primary objective of CIP's breeding programme is to incorporate resistance to major diseases and pests into desirable varieties of potatoes. To date, it has produced breeding populations with multiple resistances to certain pathogens and insect pests and with some tolerance to heat. However, while conventional breeding can rapidly incorporate resistance that is governed by a single gene, resistance that is controlled by several genes is much more difficult to incorporate. These include resistance to late blight and many other very serious diseases and insect pests. Thus, the proposed use of advanced breeding techniques (tissue culture and restriction fragment length polymorphism (RFLP) mapping in particular) is essential in accelerating breeding for resistance to the potato's most serious insect pests and diseases.

6. The proposed research will focus on two genetic traits which will reduce the need and use of synthetic chemical pesticides: (a) late blight resistance, and (b) glandular trichomes. The former will provide a long-term protection against one of the most serious and economically important fungal

diseases of the potato. The latter will provide broad-spectrum resistance to major insect pests such as aphids (which spread most major potato viruses), potato tuber moth (the most damaging potato insect), and the Colorado potato weevil, potato leafhoppers, thrips and mites. Conventional breeding for both traits has produced promising breeding populations and the entire process will now be rapidly advanced with the new breeding techniques.

7. Several recent studies have demonstrated the potential of using tissue culture of potato hybrids to produce variant plants that have leaf hairs (glandular trichomes). These leaf hairs provide general protection against several serious insect pests, but cannot be easily bred into productive potato varieties using classical plant breeding techniques. This project will thus extend and exploit this finding by introducing and strengthening modern tissue culture technology in potato breeding efforts. The efficient extraction of late blight resistance genes from wild potato species using RFLP technologies will result in the rapid development of improved potato populations for national breeding programmes. This will accelerate the process of conventional breeding for pest and disease resistance and reduce dependence on synthetic chemical pesticides.

8. Refinement and transfer of these advanced technologies will strengthen the institutional research capacity of developing country potato improvement programmes. Training of national agricultural research systems (NARS) scientists will be conducted on RFLP technology, tissue culture, breeding, germplasm exchange and testing through individual training, group courses, meetings and workshops. These advanced technologies will be available to interested NARS potato improvement programmes through the regional programme network. CIP will also develop and maintain a global data bank for the potato genetic linkage maps that will be developed by the project. This information will be freely available to all national potato improvement programmes. Potato varieties developed using RFLP and tissue culture technologies are considered as varieties produced by conventional breeding (not genetic engineering). The molecular techniques only complement and facilitate the process. Therefore, none of the materials obtained through the application of these new methods will be affected by biotechnology bio-safety concerns.

9. Institutions in developing countries (Colombia, Kenya, Philippines), among others, will directly participate in the proposed collaborative research on the application of the RFLP and tissue culture to potato improvement. The Institute of Biotechnology and Microbiology in the Philippines, the Instituto de Biología Molecular in Argentina, and other laboratories and scientists in the UNDP Latin American Biotechnology Network will contribute advanced technology to the project. CIP will also collaborate with the Scottish Crop Research Institute and the Research Institute for Plant Protection of the Netherlands to gain appropriate knowledge on RFLP and its application to potatoes. Furthermore, the advanced breeding material developed by this collaborative research project will be incorporated into integrated pest managment strategies that will be developed and tested by these regional networks. These include the Programa Regional Cooperativo de Papa, the Southeast Asian Programme for Potato Research and Development and the

International Centre for Advanced Mediterranean Agricultural Studies. Finally, certain countries in Eastern Europe and the Commonwealth of Independent States may wish to participate in the project.

10. There have been a large number of multilaterally and bilaterally funded potato breeding and training projects of a classical nature. This proposal builds on the policies, institutions and scientific and extension capability that has been developed through these many activities. Furthermore, building on CIP's past record of decentralizing their research and development to the country and regional level, the project will establish firm linkages with national programmes.

11. There are several items in the proposal that recommend it for funding from the global programme. The proposal includes collaborative potato research with three developing countries, three regional networks as well as the Regional Bureau for Latin America and the Caribbean (RBLAC) Biotechnology Network, and five other advanced laboratories in the United Kingdom, the Netherlands, United States of America, Philippines and Argentina. It will promote the exploitation of recent advances in molecular genetics in tropical potato development in order to reduce the current dependence on high levels of synthetic chemical pesticides for control of some serious potato insects and diseases. Thus, the proposal contains major elements dealing with the following themes that were identified by the Governing Council at its thirty-seventh session (1990): TCDC; technology for development; natural resource management for sustainable development.

12. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

13. Over the three-year period, approximately 16 per cent of the total budget of $4,675,000 will be used for training of developing country scientists and technicians, 12 per cent for IPM and breeding networks in Asia, Latin America, the Arab States and Africa, 22 per cent for advanced research subcontracts with developed and developing country institutes in the Netherlands, United Kingdom, United States, Philippines, Argentina and others in the Latin American biotechnology network, and 50 per cent for support of research at CIP, Lima, Peru.

14. In summary, this project will promote sustainable production systems that reduce or eliminate dependence on costly synthetic chemical pesticides. This will be achieved through: (a) biotechnology-assisted breeding to produce varieties with durable resistance to major potato diseases and insect pests; (b) development of an integrated pest management system (IPM); and (c) training of developing country nationals in biotechnology, breeding for resistance, and IPM. Adaptive research will also be conducted to combine resistant cultivars with other IPM components to prolong the duration of resistance of cultivars produced through biotechnology-assisted breeding. Results expected at the end of the project include high-yielding germplasm

with higher levels of durable resistance to late blight, as well as germplasm with higher densities of glandular trichomes to provide resistance to important potato pests. Such germplasm, with good yields and environmental adaptation, will be a major component of sustainable farming systems in developing countries. The ultimate beneficiaries will be resource-poor potato farmers and consumers. Pest- and disease-resistant germplasm will be made available to national programmes through CIP's extensive collaborative country programmes and networks in over 50 countries. IPM technologies incorporating resistant varieties, would also be developed and promoted for sustained use in developing countries. The research capability of NARS, regional research networks, and institutions in developing countries involved in this project will be strengthened.

III. RECOMMENDATION OF THE ADMINISTRATOR

15. The Administrator recommends that the Governing Council approve this project.

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PROGRAMME PLANNING

Country and intercountry programmes and projects

ASSISTANCE FOR A GLOBAL PROJECT

A Global Musa Testing Programme (GLO/91/020)

International Network for the Improvement of Banana and Plantain (INIBAP)

Recommendation of the Administrator

Estimated UNDP contribution	$4,810,000
Duration	Three years
Executing agency	OPS in consultation with FAO

I. BACKGROUND

1. Production of cooking banana and plantain for local consumption in the tropics represents about 90 per cent of total production, while production for export is about 10 per cent. Banana and plantain for local consumption are generally grown by small-scale farmers, and are often transported to urban markets. The crop plays a very important role in the economies of many countries in Asia, Africa and Latin America.

2. During the last two decades, black sigatoka (BS) and fusarium wilt disease, have disrupted the banana and plantain cultivation throughout the tropical world. By the early 1980s, BS had spread over most of the Latin American countries. In Africa, BS has now covered the whole tropical area.

In South-East Asia and the Pacific, BS is endemic. Fusarium wilt (a soil-borne fungus) is present in many locations in Latin America and the Caribbean, in East Africa and in Asia. Chemical control of black sigatoka requires frequent treatment and is generally unavailable to small-scale farmers. There is no chemical control for fusarium wilt. As a consequence, the only practical defence from black sigatoka and fusarium wilt disease for small-scale farmers is developing disease-resistant varieties.

3. Because of the diversity on a global scale in host-pathogen-ecology and in fruit quality preference, new varieties need to be evaluated over a wide range of conditions. Current research on banana and plantain is minimal in most producing countries. Many of the earlier research programmes that were initiated during this century were largely discontinued after some years. Genetic improvement of banana and plantain has only recently been initiated and the first promising material has been produced by the Fundación Hondureña de Investigación Agrícola (FHIA), Empresa Brasileira de Pasquisa Agropecuaria, and the International Institute of Tropical Agriculture (IITA), in Honduras, Brazil and Nigeria respectively.

4. INIBAP was invited to join the Consultative Group on International Agricultural Research (CGIAR) as a banana and plantain research and testing network in October 1990. INIBAP differs from most CGIAR centres in that it does not have a large central research facility. Most of INIBAP's work is carried out in national programmes through a global research and testing network using research facilities in both developed and developing countries. This collaboration extends to other international centres such as the International Board for Plant Genetic Resources, and IITA (which also conducts research on banana and plantain and to specialized institutes such as to the Fundación Hondureña de Investigación Agrícola. The specific problems which INIBAP has identified as its initial research priorities are germplasm exchange, evaluation, and control of black sigatoka, banana bunchy top virus and fusarium wilt.

5. A preliminary international musa testing programme was initiated during 1991 with preparatory support from UNDP. Hybrids produced by the Fundación Hondureña de Investigación Agrícola are at present tested in a limited number of representative selection sites in Africa and Latin America for resistance/tolerance to black sigatoka. It is expected that by mid-1992 selected hybrids will be ready for further testing under various ecological conditions. Progress to date includes the following: (a) national breeding programmes have been encouraged to produce new hybrids; (b) requests have been received to have new hybrids evaluated nationally; (c) a general consensus that the international musa testing programme must be developed quickly and on a global scale with participation of all interested countries.

II. THE PROJECT

6. The purpose of the new project is to strengthen a global programme for development and evaluation of new germplasm (hybrids) in order that small-scale farmers can replace susceptible banana and plantain cultivars by

resistant cultivars which also meet local consumers' quality preferences. The project will also increase the capacity of national organizations to carry out appropriate research and testing on local banana and plantain and strengthen local genetic improvement programmes.

7. Specific activities of the project include:

(a) Further development of a global network for the production and testing of new hybrids that are resistant to black sigatoka and fusarium wilt. Initially, this will include the Fundación Hondureña de Investigación Agrícola, Empresa Brasileira de Pasquisa Agropecuaria and the International Institute of Tropical Agriculture;

(b) Confirming the character of any promising hybrids and subjecting them to international phytosanitary and quarantine criteria at the INIBAP transit centre in Belgium. The hybrids will then be propagated and distributed to representative field-testing sites around the globe;

(c) Testing and evaluating the resistance of the hybrids at eight field sites that represent major agro-ecological regions for banana and plantain production in the developing world. This includes Honduras, Costa Rica, Colombia, Nigeria, Cameroon, Burundi, Philippines and Indonesia. Following these selection trials, local evaluation trials will be performed by interested national programmes;

(d) Development of simple, rapid and practical screening techniques for resistance to black sigatoka and fusarium wilt will also be initiated at selected advanced laboratories around the globe. This could include Australia, Belgium, France, Costa Rica and other countries in the developing world;

(e) Intensive training will be offered to participants from developing countries in all phases of the programme at the collaborating research institutions;

(f) Two global meetings of collaborating scientists and representatives of interested countries will be held at appropriate sites in which breeding and field evaluation results will be presented and discussed, recommendations for organizing the next year's activities will be formulated, and special topics of particular relevance to the research and testing will be considered. In addition, visits to banana and plantain research and testing programmes in the country or region will be scheduled;

(g) Collection and maintenance of musa germplasm will be accomplished in the project. Maintenance will be accomplished by the three-four collaborating breeding programmes in Latin America, Africa and Asia, and the International Board of Plant Genetic Resources will be asked to collect in unexplored regions in Myanmar, Viet Nam, Cambodia, certain islands of Indonesia, and other independent island countries of the Pacific.

8. The project will be subject to periodic external reviews and will receive a thorough evaluation at termination. Furthermore, opportunities will be sought to collaborate with other donors, countries and institutions that may wish to associate themselves with this research.

9. The total project cost is $4,810,000. Approximately 13 per cent of this budget is for training; 14 per cent for field evaluation and breeding; 12 per cent for field collection and maintenance of musa germplasm; 40 per cent for global coordination and international meetings, sanitary verification, propagation of hybrid germplasm and distribution by INIBAP; and 20 per cent for research by advanced laboratories on improved screening techniques.

10. The ultimate primary beneficiary of this project will be the small-scale or subsistence farmer, who will gain access to banana and plantain cultivars which are resistant to black sigatoka and fusarium wilt. Preserving biodiversity of banana and plantain and reducing the need for synthetic chemical pesticides are other potential benefits.

11. There are a few national efforts on genetic improvement of banana and plantain, and these will be major participants in the project. It should be noted that the Food and Agriculture Organization of the United Nations (FAO) has been requested by the Intergovernmental Group on Bananas to operate a banana improvement project, and this project has been submitted to the Common Fund for Commodities (CFC) for possible financing. While the INIBAP programme to be entrusted to UNDP only deals with "food bananas" and plantains and not export bananas, an agreement has been prepared by FAO and INIBAP regarding division of responsibilities and collaboration for the activities described in the project proposals submitted to UNDP and CFC.

12. There are several features of the proposal that recommend it for a UNDP global project. Cooking bananas and plantains are a very important staple food in many developing countries, and are often grown in subsistence households by women. The crop is being seriously threatened by two devastating diseases (black sigatoka and fusarium wilt), and immediate action is needed at the global level to collect, evaluate, and develop resistant germplasm. Alternatively, the use of commercial synthetic pesticides, with all the accompanying risks to the environment and health, is the only possible means of protecting the crop. Extensive cooperation between developing countries participating in the research network is central to the project, and some advanced biotechnology may be exploited to strengthen the classical breeding programmes. Thus, the project incorporates the follwing themes that were identified by the thirty-seventh session of the Governing Council: poverty eradication; TCDC; technology for development.

III. RECOMMENDATION OF THE ADMINISTRATOR

13. The Administrator recommends that the Governing Council approve this project.